

## **EARTHQUAKE-RESISTANT EQUIPMENT RACK**

### Field of the Invention

(01) The subject invention relates to racks for electronic equipment and, more specifically, to an earthquake-resistant telecommunications equipment rack.

### Background of the Invention

(02) A common use of equipment racks of the type to which the present invention relates is for carrying telephone circuitry in a building. In general, such racks include a base, side members extending upwardly from the base, and an upper horizontal cross member connecting top ends of the side members. Equipment is mounted between the side members and wire and cable connected to the equipment is supported by the rack. Typically, each rack carries up to 400-500 pounds of equipment, and is bolted or otherwise secured to the floor.

(03) Preservation of electronic equipment during earthquakes and aftershocks for the maintenance of communications and other purposes is a major concern of earthquake preparedness. In fact, alleviation of damage and suffering could depend on the maintenance of the telephone system and broadcast facilities. Moreover, the introduction of electronic and fiber optic telephone switching equipment has significantly increased the density of calls being handled in a single equipment rack or network bay such that thousands of telephone lines can be interrupted with the loss of one bay of equipment. This has made the reliability of telephone switch equipment and its supporting structure critically important, especially with respect to earthquake resistance. Racks of this type, therefore, are required to meet minimum standards for earthquake resistance, such as the BELLCORE Zone 4 seismic test set forth in Document # GR-63-CORE.

(04) It is possible to make an equipment rack that is strong enough to avoid earthquake damage by using heavier material and more bracing members, but this adds significantly to the

cost. Heavier material and more bracing, therefore, are not a solution acceptable in the competitive environment of modern telephone systems. In addition, it has been found that lighter weight, yet more rigid equipment racks behave more favorably during shaking of the type encountered during earthquakes.

(05) During seismic motion the base of a tall, slender rack moves with the floor to which it is anchored. If the rack is sufficiently rigid and well anchored it will closely follow the motions of the base and floor. If, however, the rack is more flexible, it will move at a rate different to that of the base and floor, and consequently experience high stresses and deflections. Free-standing electronic equipment racks typically have low natural resonance frequencies in the range from 1 to 10 Hz. In earthquakes, the highest energy dissipation occurs in the 4 to 5 Hz region, thereby making the racks vulnerable to earthquake induced damage. Increasing the natural frequency of the racks above the 4 to 5 Hz range, therefore, has been found to improve the earthquake resistance of equipment racks. One way to increase the natural frequency of an equipment rack is to increase its rigidity without increasing its weight.

(06) What is still desired is a new and improved telecommunications equipment rack that is earthquake resistant. Preferable, the improved rack will include increased structural rigidity without a substantial increase in weight.

#### Summary of the Invention

(07) In response, the present invention provides a new and improved rack for electrical equipment including a base having access apertures for receiving wires and cable therethrough and mounting apertures for securing the base to a floor upon which the rack is mounted. The rack also includes a pair of vertically extending upright members which have lower ends secured to opposite sides of the base. Each upright member also has a web, opposing first and second flanges projecting from the web, and openings for mounting electrical equipment thereon. The rack additionally has a cross member extending between upper ends of the upright members.

Moreover, the base includes a bottom plate, side channels extending at an angle between the bottom plate and the webs of the upright members, and a central channel extending horizontally between the side channels. The channels provide additional strength and stiffness to the rack, without adding substantial weight to the rack.

(08) According to one aspect of the present invention, at least a portion of one of the flanges of the upright members tapers towards the web from the lower ends of the upright members, which also provide additional strength and stiffness to the rack, without adding substantial weight to the rack.

(09) According to another aspect, at least one brace is secured to the cross-member, extends through the web of each upright member, and is secured to one of the flanges of each upright member to provide additional strength and stiffness to the rack without adding substantial weight to the rack.

(10) According to a further aspect, separate flange reinforcing plates are secured flat against interior surfaces of the flanges of the upright members and extend vertically from the lower ends of the upright members. The reinforcing plates also provide additional strength and stiffness to the rack without adding substantial weight to the rack.

(11) The foregoing and other features, aspects and advantages of the present invention will become more apparent from the following detailed description of the present invention when taken in conjunction with the accompanying drawings.

#### Brief Description of the Drawings

(12) FIG. 1 is a perspective view of an electronic equipment rack braced against earthquake damage in accordance with the present invention; and

(13) FIG. 2 is a perspective view of another electronic equipment rack braced against earthquake damage in accordance with the present invention.

(14) Like reference characters designate identical or corresponding components and units between the two embodiments of the present invention.

### Detailed Description of the Invention

(15) Referring to Fig. 1, the present invention provides a new and improved electronic equipment rack 10 including features that provide the rack with exceptional strength and rigidity without substantially increasing the weight and cost of the rack 10. The rack 10 generally includes a base 12, upright members 14 extending vertically from the base 12, and a cross member 16 extending horizontally between the upright members 14. The improvements to the rack 10 include channel pieces 18, 20 reinforcing the base 12, flange stiffener plates 22, 24 secured to the upright members 14, tapered portions 26 on flanges 30 of the upright members 14, braces 32 strengthening the connection between the cross member 16 and the upright members 14, and a top wall 34 of the base 12 permanently secured between the upright members 14 but having removable access panels 36. These new and improved features help strengthen the rack 10 against earthquake damage without substantially increasing the weight or cost of the rack 10.

(16) The base 12 includes a bottom plate 38, opposing first and second end walls 40, 42 extending upward from the bottom plate, and the top wall 34 extending forward from the second end wall 42 and parallel with the bottom plate 38. A first stiffening flange 46 extends downward from a front edge of the top wall 34 and parallel with the second end wall 42, and a second stiffening flange 44 extends rearward from a top edge of the first end wall 40 and parallel with the bottom plate 38.

(17) Still referring to Fig. 1, the upright members 14 are secured to opposing ends of the bottom plate 38, the second end wall 42 and the top wall 34 of the base 12. Each upright member 14 includes a vertically extending web 48 and parallel first and second flanges 28, 30 extending outwardly from the web 48. The first flanges 28 include lips 50 extending towards the second flanges 30 and parallel with the webs 48. The cross member 16 includes a horizontally

extending web <sup>not shown</sup> 52 and parallel first and second flanges 54, <sup>not shown</sup> 56 extending downward from the web.

(18) The base 12 also includes channel-like gussets 58 secured to the bottom plate 38 and extending between the first flanges 28 of the upright members 14 and the first end wall 40 of the base 12. Each gusset 58 includes a horizontal portion 60, and inner and outer legs 62, 64 depending downwardly therefrom and disposed in contact with the bottom plate 38. The bottom plate 38 includes cut-outs 66 to accommodate the upright members 14 adjacent to gussets 58, such that lower ends of the upright members 14 are unobstructed.

(19) In order to increase the strength and the stiffness of the rack 10 without significantly increasing the weight of the rack 10, angle inserts 68 having horizontal and vertical portions 70, 72 are provided in the base 12. The inserts 68 are positioned such that the horizontal portions 70 contact the bottom plate 38 and the vertical portions 72 contact both the inner legs 62 of the gussets 58 and an inwardly facing surface of the webs 48 of the upright members 14. The base 12 includes mounting opening 74 extending through the angle inserts 68 and the bottom plate 38 for receiving bolts for securing the equipment rack 10 to a floor. The top wall 34 of the base 12 includes access openings 76 positioned over the mounting openings 74 for allowing tool access for bolting the base 12 to a floor. The removable access panels 36 are secured to the top wall 34 with screws, for example, for closing the access openings 76. Although not viewable in Fig. 1, the second end wall 42 of the base 12 includes an opening for mounting a wire connector, for example, and a removable panel 78 secured to the end wall for closing the opening.

(20) The base 12 also includes the channel pieces 18, 20. Two of the channel pieces are "side" channel pieces 18 that extend at an angle, while one of the channel pieces is a "central" channel piece 20 that extends horizontally. Each of the side channel pieces 18, 20 extends at an angle between the horizontal and vertical portions of the angle inserts. As shown in Fig. 1, the side channel pieces 18 are aligned with the joint between the gussets 58 and the upright members 14. The central channel piece 20 extends horizontally between inwardly facing edges of the

horizontal portions 70 of the angle inserts 68 and between the two side channel pieces 18. Each of the three channel pieces 18, 20 are inverted.

(21) The upright members 14 are each provided with two of the separate flange stiffener plates 22, 24, which are secured flat against interior surfaces of the flanges 28, 30 of the upright members 14 (in Fig. 1 only the flange stiffener plates 22, 24 of one of the upright members 14 are viewable, but the plates of both upright members 14 are identical). The flange stiffener plates 22, 24 extend vertically from the lower ends of the upright members 14 to a height above the second end wall 42 and the gussets 58 of the base 12. Each pair of the flange stiffener plates 22, 24 are separate and not connect as a unitary piece, through a web for example. Preferably, the reinforcing plates 22, 24 extend upward to about one-fifth the overall height of the upright members 14.

(22) The second flanges 30 of the upright members 14 are provided with the tapering portions 26. The second flanges 30 include lower portions 80 extending from the lower end of the upright members 14 to the tapering portions 26, and upper portions 82 that extend from the tapering portions to upper ends of the upright members 14. As shown in Fig. 1, the lower portions 80 extend outwardly further than the upper portions 82, and the tapering portions 26 taper inwardly from the lower portions to the upper portions. The larger lower portions 80 and tapering portions 26 provide additional stiffness and strength without enlarging the second flanges 30 along their entire length.

(23) The braces 32 strengthening the connection between the cross member 16 and the upper ends of the upright members 14 extend horizontally against an interior surface of the first flange 54 of the cross member 16. Ends of the braces 32 extend through the webs 48 of the upright members 14 and are secured against the interior surfaces of the first flanges 28 of the upright members 14. The braces 32 provide additional stiffness and strength to the rack 10 without significantly increasing the overall weight of the rack 10. Preferably, the rack 10 includes two braces 32, as shown, and each brace 32 has a length equal to at least one quarter

(25%) the length of the cross member 16. Alternatively, the rack 10 can be provided with a single long brace extending between the upright members 14 and secured to the cross member 16. However, the two short braces 32 are preferred for providing increased strength and stiffness at less weight.

(24) Preferably, the equipment rack 10 is constructed of high-tensile, low-alloy steel. In addition, all joints between the various parts of the rack 10 are preferably made by welding. The base 12 and the upright members 14 include various wire and cable access apertures, and the upright members 14 additionally include apertures of various sizes and locations to which equipment may be mounted directly or to which shelving may be mounted. While no specific electronic equipment has been shown in the drawings, it is clear that the rack 10 according to the subject invention can be used in the usual manner to support telephonic, broadcasting, and other electronic equipment.

(25) The rack 10 of the present invention is intended to meet minimum standards for earthquake resistance, such as the BELLCORE Zone 4 seismic test set forth in Document # GR-63-CORE.

(26) Fig. 2 shows another embodiment of an equipment rack 100 constructed in accordance with the present invention. The rack 100 of Fig. 2 is similar to the rack 10 of Fig. 1 such that the same elements have the same reference numbers. In the rack 100 of Fig. 2, however, the upright members 14 are reversed such that the second flanges 30 are in contact with the gussets 58 and the first flanges 28 are in contact with the second end wall 42 of the base 12.

(27) Although the present inventions have been described and illustrated in detail, it is to be clearly understood that the same is by way of illustration and example only and is not to be taken by way of limitation, the scope of the present invention being limited only by the terms of the appended claims.